1,181,063

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,181,063

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COMPLETE SPECIFICATION

Improvements in or relating to Bearings

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation established by Statute of Kingsgate House 66—74 Victoria Street, London S.W.1, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in bearings, and more particularly to a bearing which is arranged to support a force in a direction substantially normal to a rigid bearing surface of a body to be supported.

In most bearing systems employing fluid film lubrication, the fluid is contained between two apparently rigid surfaces. It is possible, however, to replace one of the two surfaces with a flexible foil. Thus a rigid shaft can be supported on a strip of flexible foil embracing, for example, 180 degrees of the periphery of the shaft. An inversion of that arrangement is to use a rigid fixed surface and a flexible foil moving over that fixed surface, as for example when the moving flexible foil is the tape of a computer tape deck.

Like all self-acting bearings, a foil bearing is subject to wear when starting and stopping. To reduce this wear and to reduce the friction in use, a fluid such as a gas can be fed under pressure to the clearance between the rigid surface and the flexible foil. For example, in the case of the flexible foil moving over a rigid fixed surface, gas can be fed under pressure to a slit in the rigid surface and the resultant flow into the clearance space aids the build-up of a self-acting lubricating film between the two surfaces of the bearing.

According to one aspect of the present invention, a bearing arranged to support a body against a force in a direction substantially normal to a rigid bearing surface of the body comprises an inner flexible wall disposed close to the bearing surface but in use separated from the bearing surface by a clearance space, an intermediate wall spaced from the inner wall to form a plenum chamber, resilient spacing means acting between the intermediate wall and an outer wall, means for the supply of fluid under pressure to the plenum chamber, and distributed ports in the inner wall through which fluid under pressure can flow from the plenum chamber into the clearance space to form a lubricating fluid film between the rigid bearing surface of the body and the inner flexible wall.

According to another aspect of the invention, a bearing device arranged to support a rotatable shaft against lateral displacement comprises at least three bearings arranged to support the shaft against forces respectively in different given lateral directions radially of the shaft, the lateral directions being so distributed about the shaft that support in all three directions will positively locate the shaft against lateral displacement, each bearing comprising an inner flexible wall disposed close to a bearing surface on the shaft but in use separated from the bearing surface by a clearance space, an intermediate wall spaced from the inner wall to form a plenum chamber, resilient spacing means acting between the intermediate wall and an outer wall, means for the supply of fluid under pressure to the plenum chamber, and distributed ports in the inner wall through which fluid under pressure can flow from the plenum chamber into the clearance space to form a lubricating fluid film between the rigid bearing surface of the shaft and the inner flexible wall.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a side elevation of bearing means for vertically supporting a rotatable horizontal shaft:—

Figure 2 is an end view of the bearing means and shaft shown in Figure 1, as viewed from the left-hand end of that Figure;

Figure 3 is a sectional end elevation taken

on the line III—III of Figure 1 and as viewed in the direction indicated by the arrows;

Figure 4 is a fragmentary perspective drawing of a part of a bearing strip shown in Figures 2 and 3;

Figure 5 is a side elevation of a journal bearing device for a horizontal shaft; and

Figure 6 is an end elevation of the bearing device shown in Figure 5, as viewed from the left-hand end of that drawing.

Referring first to Figures 1 to 4, the shaft 1 is supported against vertically downwards displacement by two bearings 3 arranged to engage the shaft respectively near its two ends. Each bearing 3 includes an outer wall 5 which extends in the form of a U and is supported along its upper two edges by clamping to a horizontal beam 7. The outer wall 5 supports an inner flexible wall 9 which initially also is in the form of a U with a uniform wall spacing, about the periphery of the bearing, from the outer wall 5. When the shaft 1 is in place, as shown in Figure 3 this inner wall 9 is distorted. The upper edges of the inner wall are secured to the outer wall 5 by spacer members 11. A plenum chamber 13 is provided on the outerside of the inner wall. As shown in Figure 4, the wall 14 of the plenum chamber is formed from a strip of rubber material which has a cloth backing on its outer side and on the inner side is formed with numerous pimples 15 which are integral with the wall. By way of example, an experimental bearing was made using a sheet of the material used for the rubber facing of a table-tennis bat, a strip of the desired width being cut off in such a manner that the bias of the cloth backing extends across the width of the strip. Along two marginal parts 17 of the strip material, the pimples 15 were ground off to provide a surface suitable for fixing by a suitable adhesive to the inner wall. The inner wall 9 is in the form of a brass foil 0.002 to 0.005 inch thick. If a steel foil is used, a thinner foil would be used for the same duty. The thickness of 0.003 inch for a brass foil, used to provide a bearing for a shaft of 2 inches diameter, was found to give satisfactory results. Inner wall foil 9 is first secured to the intermediate, plenum-chamber wall 14 which is bent as shown in Figure 4 to provide the plenum chamber 13, and then numerous small holes 19 are drilled through the metal foil inner wall 9.

The outer wall 5 is in the form of a brass foil having a thickness of 0.005 inch, and the space between the outer side of the plenum chamber wall 14 and the outer wall 5 is filled with an elastic member 21 in the form of a strip of half-inch thick plastics foam of the 'open cell" type.

In use of the bearings described above, the air supplied to the plenum chamber 13 through the pipe 23 flows out through the holes 19 into the space between the inner wall 9 and the shaft 1. This air forms a lubricating film which even at shaft speeds approaching zero gives substantially zero frictional resistance to turning of the shaft. As the shaft speed increases, the pressure in the space between the inner wall 9 and the shaft 1 tends to build up in known manner to provide a lubricating film of air, but it is at low shaft speeds that the air supplied from the plenum chamber provides the advantage of effective lubrication. It will be seen that at all times the flexible inner wall with its plenum chamber is radially supported by the elastic member 21. As a result, the inner pressurised foil wall 9 does not take the tensile stresses due to the load but exists under radial pressure from the elastic member, the load capacity required is reduced gradually near the line of divergent clearance and the foil is in constant curvature over its area of contact with the shaft.

The bearing shown provides firstly self-alignment with the shaft and secondly the possibility of self-adjustment of the bearing to the size of the shaft. Further, since it operates with an almost constant clearance space, it operates with substantially zero eccentricity.

The bearings described above are adapted to carry a load which always has a given radial orientation, namely vertically downwards. In many cases a shaft must be supported against radial movement in any direction, and in such a case the bearing device illustrated in Figures 5 and 6 can be used. In that device three bearings 31, 33 and 35 are used adapted to support the shaft 37 against loads in the directions 41, 43 and 45 respectively. These three bearings have their outer walls secured to and supported by a ring-like member 49 encircling the shaft, and the three bearings engage respectively three different axial lengths 51, 53 and 55 of the shaft.

WHAT WE CLAIM IS:—

1. A bearing arranged to support a body against a force in a direction substantially normal to a rigid bearing surface of the body, comprising an inner flexible wall disposed close to the bearing surface but in use separated from the bearing surface by a clearance space, an intermediate wall spaced from the inner wall to form a plenum chamber, resilient spacing means acting between the intermediate wall and an outer wall, means for the supply of fluid under pressure to the plenum chamber, and distributed ports in the wall through which fluid under pressure can flow from the plenum chamber into the clearance space to form a lubricating fluid film between the rigid bearing surface of the body and the inner flexible wall.

2. A bearing device arranged to support a rotatable shaft against lateral displacement, comprising at least three bearings arranged to support the shaft against forces respectively in different given lateral directions radially of the shaft, inner wall to form a plenum chamber, resulient

the shaft that support in all these directions will positively locate the shaft against lateral displacement, each bearing comprising an inner flexible wall disposed close to a bearing surface on the shaft but in use separated from the bearing surface by a clearance space, an intermediate wall spaced from the inner wall to form a plenum chamber, resilient spacing means acting between the intermediate wall and an outer wall, means for the supply of fluid under pressure to the plenum chamber, and distributed ports in the inner wall through which fluid under pressure can flow from the plenum chamber into the clearance space to form a lubricating fluid film between the rigid bearing surface of the shaft and the inner flexible wall.

3. A bearing as claimed in claim 1, or a bearing device as claimed in claim 2, wherein the intermediate wall of the, or each, bearing is spaced from the inner wall by resilient spacers carried by the intermediate wall and not connected positively to the inner wall at least over most of the area thereof which overlies the clearance space.

4. A bearing or bearing device as claimed in claim 3, wherein the resilient spacers are formed integrally with the intermediate wall.

5. A bearing as claimed in claim 1, or claim 3 when appendant to claim 1, or claim 4 when appendant indirectly to claim 1, or a bearing device as claimed in claim 2, or claim 3 when appendant to claim 2, or claim 4 when appendant indirectly to claim 2, wherein the intermediate wall is radially supported on its outer side by an elastic member.

6. A bearing or bearing device as claimed in claim 5, wherein the elastic member is arranged to support the intermediate wall over substantially the whole of that portion of its area which overlies the clearance space.

7. A bearing or bearing device as claimed in claim 5 or 6, wherein the elastic member is in the form of open-celled foamed plastics material.

8. A bearing substantially as shown in, and adapted to operate substantially as hereinbefore described with reference to, figures 1 to 4 of the accompanying drawings.

9. A bearing device substantially as shown in, and adapted to operate substantially as hereinbefore described with reference to, figures 5 and 6 of the accompanying drawings.

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1181063 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

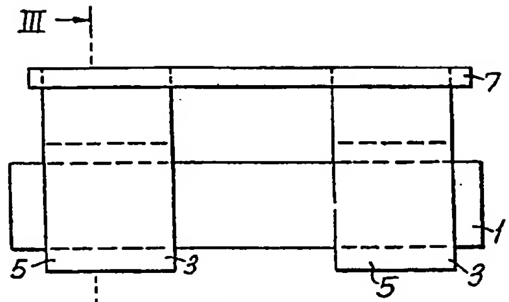

FIG.1.

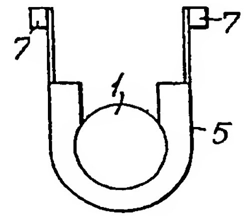

FIG.2.

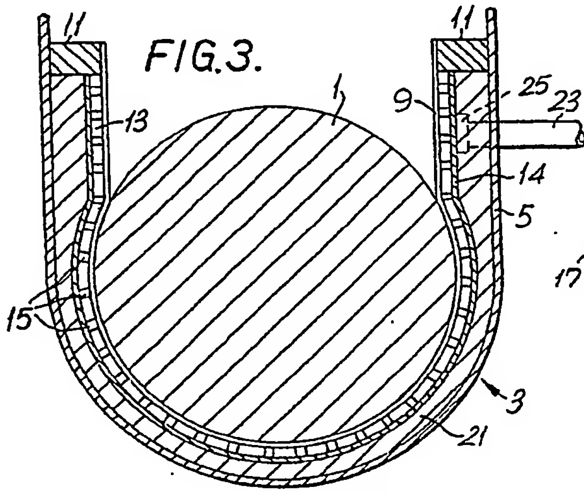

FIG.3.

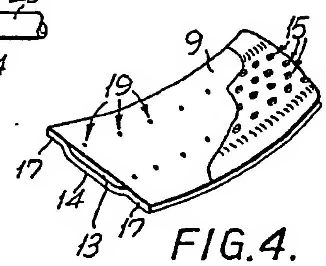

FIG.4.

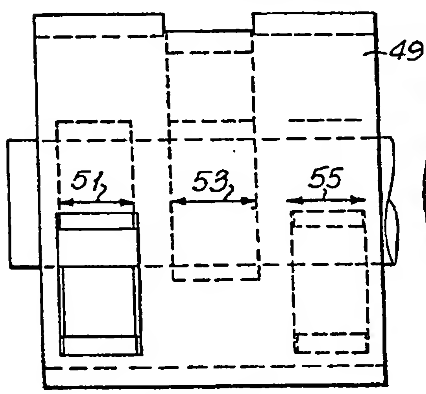

FIG.5.

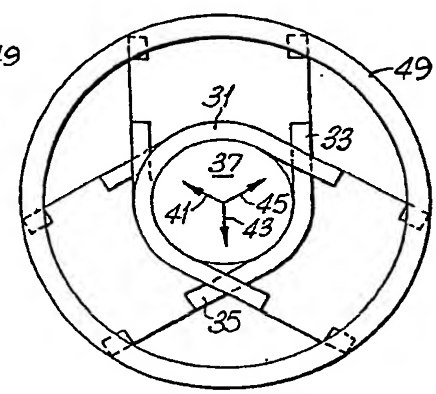

FIG.6.